ent in the arctic regions from that which prevails in more moderate latitudes; but it serves fully to prove the impossibility of forming any hypothesis respecting the constitution of the atmosphere which shall be universally correct.

Following the above Dr. Young gives some notes as to the effect of a change of a degree Fahrenheit on the astronomical refraction.

Shortly after this time, viz, in the Edinburgh Journal of Science, 1827, Vol. VI, page 246, Sir Thomas Brisbane quotes Fisher's experiments and Dr. Young's remarks in connection with observations made at Port Macquarie, Van Diemens Land, in June, 1824, at an upper and lower station, for the purpose of determining the decrease of temperature with altitude.

In the Edinburgh Journal for January, 1827, Vol. VI, p. 146, Brewster, as editor, commenting on the hourly observations proposed by the Royal Society of Edinburgh, used the following words:

To those meteorologists who have sufficient leisure and the means of performing such experiments, we would recommend the use of kites or of balloons for ascertaining the temperature and state of the upper atmosphere. The Earl of Minto has obtained several very interesting results by the use of balloons.

The observations by the Earl of Minto here referred to were given in the subsequent volume, page 249, where it appears that small captive balloons were used up to a height of 1,340 feet. An observer ascended with the balloon; the height was varied frequently by letting out or pulling in the line. The rise of temperature after sunset at the upper station was well established.

Another account of the experiment by Rev. George Fisher is given at page 187 of the volume of scientific memoirs published at London, 1825, as the Appendix to Captain Parry's Journal of the Second Voyage for the Discovery of the Northwest Passage. In the Appendix No. 2, on Atmospheric Refraction, on page 187, Mr. Fisher says:

It appears by an experiment that when the sea is covered with ice in the winter there is no sensible difference between the temperatures of the atmosphere at the surface of the ice and at the height of 400 feet above it. This was tried by means of a paper kite with an excellent register thermometer attached to it, the altitude of which was determined by two different observers at the time, at a given distance from each other and in the same vertical plane as the kite, and from which the perpendicular height of the kite above the level of the ice was computed. This experiment was tried under favorable circumstances at a temperature of —24° F. The kite was sent up and caught in coming down without the thermometer being in the least disturbed, the indices of which did not show the slightest alteration although carefully compared before and after these experiments and the kite remained at the same height in the air for a considerable time.

There is nothing to show the special date on which this experiment was made, but it may be safely assumed to have been in February or March, 1823. Whether the upper temperature was lower or higher than that near the earth's surface would have been shown by Mr. Fisher's thermometer, since it appears to have been a self-registering Six thermometer in an iron case, whose two indices would respectively show the maximum and the minimum that occurred during each experiment. Of course the iron case or inclosure which protected this thermometer from accident also greatly increased its sluggishness from a thermometric point of view, and as the thermometer remained at its highest altitude only five or ten minutes, it could not be expected to settle a question of a difference of less than 5° F.

The preceding investigations seem to the Editor to have all been suggested by the active discussion that was in those days going on as to the formula for refraction in the atmosphere, in which Dr. Thomas Young and Mr. Ivory took a prominent part.

ARCHIBALD ON KITES.

A little book has just been published in London, entitled The Story of the Earth's Atmosphere, by Douglas Archibald. This volume contains a very readable, popular account of the general composition, temperature, and circulation of the atmosphere, written by one who has himself contributed something to the progress of meteorology. From Chapter XIII we quote the following. After some remarks on balloons and flying machines, Mr. Archibald says:

When a plane surface is forced through the air, the upward pressure of the air is mostly concentrated near its front edge. If the surface extended far back from the edge, its weight would act at some distance from the front edge. Consequently, the unbalanced pressure of the air would tend to turn the plane over backwards. If, however, its width were small, the weight would act so close to where the resistance acts in the opposite direction that the forces would neutralize each other and stability ensue.

Mr. Hargrave has adopted this principle in his cellular or box kite, whose construction is sufficiently obvious to render detailed description unnecessary.

The dimensions are as follows: The length of each cell (from right to left) is 30 inches, and the width and height and opening between are about 11 inches; but these dimensions may vary so long as the two cells together form a nearly square area. An important feature of this peculiar, tailless kite consists of the covered-in sides. These ensure stability even better than two planes bent upward in V shape, such as the wings of the kestrel when hovering, and they prevent the kite from upsetting, very much as the sides of a ship give it stability.

Mr. Maxim once showed the advantage of such side planes by a simple experiment in which a piece of paper, when held horizontally and let fall to the floor, is seen to execute a series of zigzags in the air, frequently ending in its complete overthrow; whereas when the same piece of paper is folded up round the edges like a boat, it sails to the floor quite evenly and in a straight line. * * *

The *kite* was first invented by the Chinese General Han Sin in 206 B. C., for use in war, and was frequently employed after that date in China by the inhabitants of a besieged town to communicate with the outside world. After this kites appear to have degenerated into mere toys.

At the middle of the present century, however, Pocock of Bristol employed them to draw carriages, and is said to have traveled from Bristol to London in a carriage drawn by kites. They were also occasionally employed to measure the temperature of the upper air, by Admiral Back, on the *Terror*, and Mr. Birt, at Kew, in 1847.

These observations had been quite forgotten when the author first suggested the employment of kites for systematic observations in 1883. It has since been discovered that Dr. Wilson, of Glasgow, as long ago as 1749, resuscitated kites from their long burial with a similar idea of employing them to measure temperature.

In the author's experiments, steel wire was first employed to fly them with. Two kites of diamond pattern, made of tussore silk and bamboo frames, were flown tandem, and four self-recording Biram anemometers, weighing 1¼ pounds each, were attached at various points up the wire. Heights from 200 to 1,500 feet were reached by the instruments, and the increase of the average motion of the atmosphere was measured on several occasions for three years. Kites were also employed first, by the author, in 1887, to photograph objects below by means of a camera attached to the kite wire, the shutter being released by explosion. Since that time kite photography has leapt into popularity and has been successfully practised by M. Batut, in France, Capt. Baden Powell, in England, and Eddy, in New Jersey. * * *

It was further suggested by the author, in 1888 (Les Cerfs Volants Militaires. Bibliothèque des Connaissances Militaires. Paris, 1888.), that kites could be used for various purposes in war as well as science.

Since then Capt. Baden Powell, in May, 1895, read a paper on "Kites, their uses in War." In both these publications it was pointed out that kites possessed several distinct advantages over balloons; next, that they could be applied to all the purposes for which balloons could be employed, such as signalling, photography, torpedo projection, carrying despatches between vessels, and, lastly, they could be employed to raise a man for purposes of reconnaissance.

EFFICIENCY OF WINDMILLS.

In his Story of the Earth's Atmosphere, Mr. Douglas Archibald, says:

It is estimated that there are more than a million windmills in the United States alone. The useful efficiency of windmills, especially in the modern geared form, is comparable with that of the best simple steam engines.

A geared modern wheel, 20 feet in diameter, will develop 5-horse power in an 18 mile an hour breeze, and can be applied to work agricultural machinery and dynamos for electric lighting. With a single wheel of this size Mr. McQeesten, of Marblehead Neck, Mass., U. S.

A., works an installation of 137 electric lights, for which he formerly used a steam engine; as a result he finds that he effects a saving of more than 50 per cent.

According to Lord Kelvin, wind still supplies a large part of the energy used by man. Out of 40,000 of the British shipping, 30,000 are sailing ships, and as coal gets scarcer "wind will do man's work on land, at least in proportion comparable to its present doing of work at sea, and windmills or wind motors will again be in the ascendant."

THE FRANKLIN KITE CLUB AND JAMES SWAIM.

In the American Journal of Science for 1837, Vol. XXXII, pp. 304–307, there is an article by James Swaim (b. 1816, d. 1877), describing some observations by himself, made October and November, 1836, for the purpose of determining daily the height of that layer of electrified air "whose positive electricity was concentrated enough to expand the leaves of the electrometer." Such measurements would of course determine the height of a layer having a constant difference of potential with regard to the earth's surface at the lower end of the wire. Mr. Swaim used a kite and apparatus which he describes as follows:

The preceding experiments were made with common three-stick kites, two feet six inches long and two feet four inches wide, tapering from the middle to the top. Wire No. 30 was used, which was wound on a reel four feet in circumference, having a glass axle running on a frame about three feet high, which was made in the same manner as the one used by the Franklin Kite Club of Philadelphia.

An electrometer was connected with an iron ring through which the wire passed, and which was suspended by means of silk in front of the reel for the purpose of preventing the wire from running off in winding up rapidly.

Also an instrument was used for finding the height of the kite, which I constructed in the following manner: Two stationary arms of different lengths were placed at right angles. The longer of these was graduated into small equidistant divisions. A movable arm, which was graduated in the same manner, was attached to the short arm, into which was let a level. This instrument was attached to the front of the reel stand by means of a screw, on which it could move.

The height of the kite was found by means of a simple proportion. Mr. Swaim also publishes the meteorological observations made by him at the surface of the earth, concerning which he says:

The dew-point was found from the following formula, discovered by Mr. Espy: Take two thermometers (Fahrenheit) that agree, or allow for the difference; cover one of the bulbs with a wet rag and suspend them in the shade where there is a draft of air, or fan them briskly until they become stationary. Then the difference of the thermometers being multiplied by one hundred and three, the product divided by the number of degrees indicated by the wet bulb, and the quotient subtracted from the number of those indicated by the dry one, will give the dew-point.

From the above we infer that wire was used both by the Franklin Kite Club before 1836, and by Mr. Swaim in that year. The "three-stick kites" described by him are sometimes called "house kites," and have the form of an irregular but symmetrical hexagon.

The reference to Espy's use of the "whirled psychrometer" is important as confirming the conclusion long since published by the Editor, that Espy was the first who practiced this use of the instrument.

KITES IN AMERICA AND EUROPE.

The active meteorologists of to-day with their abundance of scientific periodicals do not easily realize the difficulties under which our ancestors labored a century ago. Before the establishment of Silliman's American Journal of Science, 1818, and the Franklin Journal, or the Journal of the Franklin Institute by Dr. Jones in 1826, Americans necessarily looked to England and France for the records of the progress of science. The journals that were most widely circulated among us were Tilloch's Philosophical Magazine, Nicholson's Journal of Natural Philosophy, Phillip's Annals of Philosophy, Brewster's Edinburgh Journal of Science, and Young's Quarterly Journal of Science, and in these we must search, not only for American contributions, but also for the articles that stimulated American workers and the ideas that were prevalent among them. The modern application of the kite to meteorological work illustrates very prettily this interchange of ideas between Great Britain and America. Franklin and his electric kite of 1748 were but tales of the past when, in 1825, the memoir of Prof. Alexander Wilson (which had lain neglected for thirty-six years among the papers of his son, Prof. Patrick Wilson) was published in the Transactions of the Royal Society of Edinburgh, and almost at the same time was largely reprinted in Thomson's Annals of Philosophy for November, 1826 (apparently the last volume before the Annals were united with the Philosophical Magazine). An abstract of this paper was published as promptly as possible in the Franklin Journal for March, 1827, Vol. III, p. 182, and must have at once fallen into the hands of Espy, who was at that time studying meteorological matters. About this time, also, he must have read Fisher's article in the Quarterly Journal for 1826, and soon began his own experiments with kites. He must, also, have seen Harvey's article in the Encyclopedia Metropolitana in 1834, as that encyclopedia was widely circulated in the United States. Espy's theories as to atmospheric currents and storms, the temperature of the air, and the formation and heights of clouds, supported as they were by his own observations with kites and those of the Franklin Kite Club, excited much attention in Europe between 1835 and 1845. The discussions on his theories preceded, if they did not directly lead to, the attempt of Birt and Ronalds in 1847 at the Kew Observatory to determine the real condition of the atmosphere above us as to temperature and moisture. Their experiments were given up as unsatisfactory and the kite seems to have been abandoned—if I may except some observations of my own in 1867 at Washington and 1876 at Atlantic City and those of Van Rysselbergh in Belgium in 1880—until Archibald began his valuable work in England in November, 1883. The scanty use made of the kite during this interval resulted very largely from the fact that the balloon had absorbed attention and, indeed, seemed at first to offer all the facilities needed for the exploration of the upper air. Afterwards balloon work was supplemented by the establishment of mountain stations, beginning with Mount Washington, 1870, and Pikes Peak, 1873. But the progress of dynamic meteorology had shown the need of regular observations from stations that are more perfectly isolated from terrestrial influences than is possible on a mountain top. The Eifel tower seemed to perfectly respond to our needs, but such towers are expensive and rare. A few isolated investigations by no means respond to the needs of dynamic meteorology. The work done with balloons, kites, and mountain stations was reviewed in my lectures of 1882–85, showing that we must have maps of the upper isobars, isotherms, and winds and, to this end, must increase the number of our mountain stations and stimulate the use of balloons. In June, 1885, Mr. McAdie used kites to study atmospheric electricity at Blue Hill in extension of his studies under Professor Trowbridge at Cambridge. In my official estimates of July, 1885, and September, 1886, respectively, I included "kites, wire, reels, and sextant for the study of wind pressure" and, again, "kites, etc., for the study of temperature and wind at moderate elevations," as supplementary to balloons and mountain stations. But the important stimulus was given to this kite work by Eddy at Bayonne, N. J., in 1890, and just at this opportune moment Hargarve, in 1893, at Sydney, Australia, contributed to the progress of science his unique and valuable cellular kite, a full account of which was read at the Columbian Exposition, Chicago, 1893. Since then Eddy's work has been carried forward at Blue Hill by Mr. Rotch and his assistants, while